ABSTRACT

Soft decision sections (503, 506) provisionally decide each modulated signal (502, 505) separated using an inverse matrix calculation of a channel fluctuation matrix at separation section (501). Signal point reduction sections (508, 510, 514, 516) reduce candidate signal points of a multiplexed modulated signal using the provisional decision results (504, 507). Soft decision sections (512, 518) make a correct decision using the reduced candidate signal points and obtain received data (RA, RB) of each modulated signal. This allows received data RA, RB with a good error rate characteristic to be obtained with a relatively small number of calculations without reducing data transmission efficiency.

FIG.1

100 MULTI-ANTENNA COMMUNICATION SYSTEM

111 TRANSMISSION SECTION

121 RECEPTION SECTION

FIG.2

110 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

201B CODING SECTION

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.3

201 CHANNEL ESTIMATION SYMBOL

202 DATA SYMBOL

TIME

FIG.4

120 MULTI-ANTENNA RECEPTION APPARATUS

404 SIGNAL PROCESSING SECTION

403-1A CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL A

403-1B CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL B

403-2A CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL A

403-2B CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL B

402-1 DESPREADING SECTION

402-2 DESPREADING SECTION

401-1 RADIO SECTION

401-2 RADIO SECTION

FIG.5

404 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

508 SIGNAL POINT REDUCTION SECTION

510 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

506 SOFT DECISION SECTION

514 SIGNAL POINT REDUCTION SECTION

516 SIGNAL POINT REDUCTION SECTION

502 NUMBER OF SIGNAL POINTS: 4

505 NUMBER OF SIGNAL POINTS: 4

501 SEPARATION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.6

503 SOFT DECISION SECTION

603 DECISION SECTION

601 SOFT DECISION VALUE CALCULATION SECTION

FIG.11

1100 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

508 SIGNAL POINT REDUCTION SECTION

510 SIGNAL POINT REDUCTION SECTION

1101 SOFT DECISION SECTION

514 SIGNAL POINT REDUCTION SECTION

516 SIGNAL POINT REDUCTION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.12

1200 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

1201 SIGNAL POINT REDUCTION SECTION

1202 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

514 SIGNAL POINT REDUCTION SECTION

516 SIGNAL POINT REDUCTION SECTION

502 NUMBER OF SIGNAL POINTS: 4

501 SEPARATION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.13

1300 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

506 SOFT DECISION SECTION

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

502 NUMBER OF SIGNAL POINTS: 4

505 NUMBER OF SIGNAL POINTS: 4

501 SEPARATION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.14

MODULATED SIGNAL A

ST1A SOFT DECISION

DIGITAL SIGNAL OF MODULATED SIGNAL B

ST2A SIGNAL POINT REDUCTION

ST3A SOFT DECISION

DIGITAL SIGNAL OF MODULATED SIGNAL B

ST4A SIGNAL POINT REDUCTION

ST5A SOFT DECISION

MODULATED SIGNAL B

ST1B SOFT DECISION

DIGITAL SIGNAL OF MODULATED SIGNAL A

ST2B SIGNAL POINT REDUCTION

ST3B SOFT DECISION

DIGITAL SIGNAL OF MODULATED SIGNAL A

ST4B SIGNAL POINT REDUCTION

ST5B SOFT DECISION

FIRST SOFT DECISION

SECOND SOFT DECISION

THIRD SOFT DECISION

FIG.15

1 FRAME OF MODULATED SIGNAL A

1 FRAME OF MODULATED SIGNAL B

FIRST ERROR CORRECTION

REFLECTS FIRST ERROR CORRECTION AND REDUCES NUMBER OF STATES

1 FRAME OF MODULATED SIGNAL A

1 FRAME OF MODULATED SIGNAL B

SECOND ERROR CORRECTION

FIG.16

MODULATED SIGNAL A

GOOD

RECEPTION QUALITY

BAD

C/N (CARRIER POWER VS. NOISE POWER RATIO)

BAD

RECEPTION FIELD INTENSITY

GOOD

1601 AFTER FIRST SOFT DECISION RESULT

1602 AFTER SECOND SOFT DECISION RESULT

1603 AFTER THIRD SOFT DECISION RESULT

1604 AFTER FOURTH SOFT DECISION RESULT

MODULATED SIGNAL B

GOOD

RECEPTION QUALITY

BAD.

FOR C/N (CARRIER POWER VS. NOISE POWER RATIO)

BAD

RECEPTION FIELD INTENSITY

GOOD

1605 AFTER FIRST SOFT DECISION RESULT

1606 AFTER SECOND SOFT DECISION RESULT

1607 AFTER THIRD SOFT DECISION RESULT

1608 AFTER FOURTH SOFT DECISION RESULT

FIG.17

1700 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

1701 SIGNAL POINT REDUCTION SECTION

1702 SIGNAL POINT REDUCTION SECTION

1705 SOFT DECISION SECTION

1703 SIGNAL POINT REDUCTION SECTION

1704 SIGNAL POINT REDUCTION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.18

1800 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

1801 SIGNAL POINT REDUCTION SECTION

1802 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

1803 SIGNAL POINT REDUCTION SECTION

1804 SIGNAL POINT REDUCTION SECTION

502 NUMBER OF SIGNAL POINTS: 4

501 SEPARATION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.19

MODULATED SIGNAL A

FIRST SOFT DECISION

ST10A FIRST SOFT DECISION

DIGITAL SIGNAL OF SPREADING SIGNAL B

ST11A SIGNAL POINT REDUCTION

THIRD SOFT DECISION

ST12A SOFT DECISION

DIGITAL SIGNAL OF SPREAD SIGNAL A

MODULATED SIGNAL B

DIGITAL SIGNAL OF SPREAD SIGNAL A

ST10B SIGNAL POINT REDUCTION

ST11B SOFT DECISION

SECOND SOFT DECISION

FIG.20

MODULATED SIGNAL A

GOOD

RECEPTION QUALITY

BAD

C/N (CARRIER POWER VS. NOISE POWER RATIO)

BAD

RECEPTION FIELD INTENSITY

GOOD

2001 AFTER FIRST SOFT DECISION RESULT

2003 AFTER THIRD SOFT DECISION RESULT

MODULATED SIGNAL B

GOOD

RECEPTION QUALITY

BAD

C/N (CARRIER POWER VS. NOISE POWER RATIO)

BAD

RECEPTION FIELD INTENSITY

GOOD

2006 AFTER SECOND SOFT DECISION RESULT

2008 AFTER FOURTH SOFT DECISION RESULT

FIG.22

GOOD

RECEPTION QUALITY

BAD

C/N (CARRIER POWER VS. NOISE POWER RATIO)

BAD

RECEPTION FIELD INTENSITY

GOOD

FIG.23

2300 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

2301A INTERLEAVER

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

201B CODING SECTION

2301B INTERLEAVER

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.24

2400 SIGNAL PROCESSING SECTION

2405A INTERLEAVER

2405B INTERLEAVER

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

2403A DEINTERLEAVER

2404A DEINTERLEAVER

2403B DEINTERLEAVER

2404B DEINTERLEAVER

2402A INTERLEAVER

2402B INTERLEAVER

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

506 SOFT DECISION SECTION

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

2401A DEINTERLEAVER

2401B DEINTERLEAVER

501 SEPARATION SECTION

FIG.25

(A)

MODULATED SIGNAL A

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

(B)

MODULATED SIGNAL B

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

FIG.26

(A)

MODULATED SIGNAL A

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

(B)

MODULATED SIGNAL B

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

TIME

DECODING

FIG.27

IDENTICAL INTERLEAVING: NO ITERATIVE DECODING

IDENTICAL INTERLEAVING: ITERATIVE DECODING ONCE

IDENTICAL INTERLEAVING: ITERATIVE DECODING FIVE TIMES

DIFFERENT INTERLEAVING: NO ITERATIVE DECODING

DIFFERENT INTERLEAVING: ITERATIVE DECODING ONCE

DIFFERENT INTERLEAVING: ITERATIVE DECODING FIVE TIMES

FIG.28

(A)

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

(B)

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 9

DATA 17

DATA 25

DATA 176

DATA 184

DATA 192

DATA 200

FIG.29

(A)

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

(B)

DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

FREQUENCY OR TIME

(C)

DATA 185

DATA 190

DATA 195

DATA 200

DATA 1

DATA 6

DATA 11

DATA 16

FREQUENCY OR TIME

FIG.30

2700 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

202A MODULATION SECTION

204A RADIO SECTION

201B CODING SECTION

202B MODULATION SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.31

(A)

MODULATED SIGNAL A

TRANSMISSION SIGNAL

CODING IN FREQUENCY AXIS DIRECTION

CODING IN TIME AXIS DIRECTION

FREQUENCY

CARRIER 1

CARRIER 2

CARRIER 3

CARRIER 4

CARRIER 5

TIME

TIME 1

TIME 2

TIME 3

TIME 4

TIME 5

TIME 6

TIME 7

TIME 8

TIME 9

(B)

MODULATED SIGNAL B

TRANSMISSION SIGNAL

CODING IN FREQUENCY AXIS DIRECTION

CODING IN TIME AXIS DIRECTION

CARRIER 1

CARRIER 2

CARRIER 3

CARRIER 4

CARRIER 5

FREQUENCY

TIME

TIME 1

TIME 2

TIME 3

TIME 4

TIME 5

TIME 6

TIME 7

TIME 8

TIME 9

PILOT SYMBOL

DATA SYMBOL

FIG.32

2900 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

2301A INTERLEAVER

202A MODULATION SECTION

204A RADIO SECTION

201B CODING SECTION

2301B INTERLEAVER

202B MODULATION SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.33

3000 MULTI-ANTENNA RECEPTION APPARATUS

3002 SIGNAL PROCESSING SECTION

403-1A CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL A

403-1B CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL B

403-2A CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL A

403-2B CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL B

401-1 RADIO SECTION

401-2 RADIO SECTION

FIG.34

(A)

MODULATED SIGNAL A

RIGHT SYMBOL

RIGHT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

(B)

MINIMUM VALUE OF PATH METRIC

TIME

(C)

MODULATED SIGNAL B

RIGHT SYMBOL

WRONG SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

WRONG SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

WRONG SYMBOL

RIGHT SYMBOL

WRONG SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

WRONG SYMBOL

(D)

MULTIPLIER

TIME

DECODING

FIG.35

MODULATED SIGNAL A

TRANSMISSION SIGNAL

3301 CHANNEL ESTIMATION SYMBOL

3302 DATA SYMBOL

3303 STBC SYMBOL

3304 DATA SYMBOL

3305 STBC SYMBOL

3306 DATA SYMBOL

TIME

4 SYMBOLS

2 SYMBOLS

4 SYMBOLS

2 SYMBOLS

4 SYMBOLS

MODULATED SIGNAL B

TRANSMISSION SIGNAL

3307 CHANNEL ESTIMATION SYMBOL

3308 DATA SYMBOL

3309 STBC SYMBOL

3310 DATA SYMBOL

3311 STBC SYMBOL

3312 DATA SYMBOL

TIME

FIG.36

TIME t

TIME t

TIME t+1

TIME t+1

TRANSMISSION SECTION

RECEPTION SECTION

TIME t

TIME t+1

FIG.37

202A(202B)

3501 DATA SYMBOL SIGNAL GENERATION SECTION

3502 STBC SYMBOL SIGNAL GENERATION SECTION

3503 CHANNEL ESTIMATION SYMBOL SIGNAL GENERATION SECTION

3508 SIGNAL SELECTION SECTION

FIG.38

3600 SIGNAL PROCESSING SECTION

4114 DECODING SECTION

4115 DECODING SECTION

4110 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

4112 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

508 SIGNAL POINT REDUCTION SECTION

510 SIGNAL POINT REDUCTION SECTION

4108 DECODING SECTION

4104 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

4109 DECODING SECTION

4106 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

514 SIGNAL POINT REDUCTION SECTION

516 SIGNAL POINT REDUCTION SECTION

4101 STBC SYMBOL BRANCH METRIC CALCULATION SECTION

501 SEPARATION SECTION

FIG.39

3700 SIGNAL PROCESSING SECTION

4114 DECODING SECTION

4115 DECODING SECTION

4110 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

4112 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

508 SIGNAL POINT REDUCTION SECTION

510 SIGNAL POINT REDUCTION SECTION

4108 DECODING SECTION

4104 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

4109 DECODING SECTION

4106 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

514 SIGNAL POINT REDUCTION SECTION

516 SIGNAL POINT REDUCTION SECTION

4101 STBC SYMBOL BRANCH METRIC CALCULATION SECTION

501 SEPARATION SECTION

FIG.40

(A)

FRAME CONFIGURATION OF MODULATED SIGNAL A

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

STBC SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

STBC SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

(B)

MODULATED SIGNAL A

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SIGNAL

WRONG SYMBOL

WRONG SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

REDUCTION OF SIGNAL POINTS

REDUCTION OF SIGNAL POINTS

(C)

MODULATED SIGNAL B

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

SIGNAL POINT SELECTION UNNECESSARY

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

SIGNAL POINT SELECTION UNNECESSARY

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

TIME

DECODING

FIG.41

MODULATED SIGNAL A

MODULATED SIGNAL B

3701 DATA SYMBOL

3703 (I,Q)=(0,0) SYMBOL

3702 (I,Q)=(0,0) SYMBOL

3704 DATA SYMBOL

TIME

FIG.42

MODULATED SIGNAL A

MODULATED SIGNAL B

3801 KNOWN DATA SYMBOL

3802 KNOWN DATA SYMBOL

TIME

FIG.43

3501 DATA SYMBOL SIGNAL GENERATION SECTION

4001 SPECIAL SYMBOL SIGNAL GENERATION SECTION

3503 CHANNEL ESTIMATION SYMBOL SIGNAL GENERATION SECTION

3508 SIGNAL SELECTION SECTION

FIG.44

(A)

FRAME CONFIGURATION OF MODULATED SIGNAL A

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

3601 SPECIAL SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

3602 SPECIAL SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

(B)

MODULATED SIGNAL A

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

REDUCTION OF SIGNAL POINTS

REDUCTION OF SIGNAL POINTS

(C)

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

SIGNAL POINT SELECTION UNNECESSARY

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

SIGNAL POINT SELECTION UNNECESSARY

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

TIME

DECODING

FIG.45

(A)

CODED SYMBOL BLOCK

DATA SEQUENCE

AFTER INTERLEAVING

(B)

TIME

TRANSMISSION SEQUENCE

FIG.46

MODULATED SIGNAL A

4401 CHANNEL ESTIMATION SYMBOL

4402 DATA SYMBOL

4403 CHANNEL ESTIMATION SYMBOL

4404 DATA SYMBOL

4405 CHANNEL ESTIMATION SYMBOL

4406 DATA SYMBOL

TRANSMITTED BY AN1

TRANSMITTED BY AN1

TRANSMITTED BY AN2

MODULATED SIGNAL B

4407 CHANNEL ESTIMATION SYMBOL

4408 DATA SYMBOL

4409 CHANNEL ESTIMATION SYMBOL

4410 DATA SYMBOL

4411 CHANNEL ESTIMATION SYMBOL

4412 DATA SYMBOL

TRANSMITTED BY AN2

RELIABILITY OF BRANCH METRIC IS LOW

TRANSMISSION BY AN3

RELIABILITY OF BRANCH METRIC IS LOW

TRANSMISSION BY AN3

RELIABILITY OF BRANCH METRIC IS HIGH

TIME

FIG.47

4500 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

201B CODING SECTION

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

4501 ANTENNA SELECTION SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.49

4700 MULTI-ANTENNA TRANSMISSION APPARATUS

4701 SIGNAL SEPARATION SECTION

4704 CODING SECTION FOR (Sa0,Sa2)

4706 CODING SECTION FOR (Sa1,Sa3)

4708 INTERLEAVER (PATTERN X)

4710 INTERLEAVER (PATTERN Y)

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

4712 SIGNAL SEPARATION SECTION

4715 CODING SECTION FOR (Sb0,Sb2)

4717 CODING SECTION FOR (Sb1,Sb3)

4719 INTERLEAVER (PATTERN X)

4721 INTERLEAVER (PATTERN Y)

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.50

MODULATED SIGNAL A

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 9

DATA 17

DATA 25

DATA 176

DATA 184

DATA 192

DATA 200

MODULATED SIGNAL B

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 9

DATA 17

DATA 25

DATA 176

DATA 184

DATA 192

DATA 200

TIME

FIG.51

4900 SIGNAL PROCESSING SECTION

4903 DECODING SECTION (FOR Sa0, Sa3)

4906 DECODING SECTION (FOR Sb1, Sb3)

4908 INTERLEAVER (FOR Sa1, Sa3)

4909 INTERLEAVER (FOR Sb1, Sb3)

4918 INTERLEAVER (FOR Sb0, Sb2)

4917 INTERLEAVER (FOR Sa0, Sa2)

4912 DECODING SECTION (FOR Sa0, Sa2)

4906 DECODING SECTION (FOR Sb0, Sb2)

4902 DEINTERLEAVER (FOR Sa1, Sa3)

4905 DEINTERLEAVER (FOR Sb1, Sb3)

4911 DEINTERLEAVER (FOR Sa0, Sa2)

4914 DEINTERLEAVER (FOR Sb0, Sb2)

4901 LIKELIHOOD DECISION SECTION

4910 LIKELIHOOD DECISION SECTION

2402A INTERLEAVER (FOR Sa0, Sa2)

2402B INTERLEAVER (FOR Sb0, Sb2)

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION (FOR Sa0, Sa2)

506 SOFT DECISION SECTION (FOR Sb0, Sb2)

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

2401A DEINTERLEAVER (FOR Sa0, Sa2)

2401B DEINTERLEAVER (FOR Sb0, Sb2)

501 SEPARATION SECTION

FIG.52

REDUCTION OF SIGNAL POINTS

FIG.53

MODULATED SIGNAL A

MODULATED SIGNAL B

ST21A Sa0, Sa2, Sb0, Sb2 DECODING

ST22A SIGNAL POINT REDUCTION

ST23A Sa0, Sa2, Sb0, Sb2 DECODING

Sa0, Sa2, Sb0, Sb2 INFORMATION

Sa1, Sa3, Sb1, Sb3 INFORMATION

Sa0, Sa2, Sb0, Sb2 INFORMATION

Sa1, Sa3, Sb1, Sb3 INFORMATION

ST21B SIGNAL POINT REDUCTION

ST22B Sa1, Sa3, Sb1, Sb3 DECODING

ST23B SIGNAL POINT REDUCTION

ST24B Sa1, Sa3, Sb1, Sb3 DECODING

FIRST DECODING

SECOND DECODING

THIRD DECODING

FOURTH DECODING

FIG.54

(A)

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

(B)

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

Sa1, Sa3 AND Sb1, Sb3 DECODING

FIG.55

(A)

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

(B)

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

Sa1, Sa3 AND Sb1, Sb3 DECODING

FIG.56

5400 MULTI-ANTENNA TRANSMISSION APPARATUS

5402 SIGNAL SEPARATION SECTION

5405 CODING SECTION

5407 INTERLEAVER (PATTERN X)

5409 SEPARATION SECTION

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

5412 CODING SECTION

5415 INTERLEAVER (PATTERN Y)

5417 SEPARATION SECTION

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.57

(A)

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

DATA 1

DATA 11

DATA 185

DATA 195

DATA 6

DATA 16

DATA 190

DATA 200

(B)

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 9

DATA 17

DATA 25

DATA 176

DATA 184

DATA 192

DATA 200

DATA 1

DATA 17

DATA 176

DATA 192

DATA 9

DATA 25

DATA 184

DATA 200

FIG.58

5600 SIGNAL PROCESSING SECTION

5608 DECODING SECTION

5610 INTERLEAVER (PATTERN Y)

5616 INTERLEAVER (PATTERN X)

5614 DECODING SECTION

5607 DEINTERLEAVER (FOR PATTERN Y)

5613 DEINTERLEAVER (FOR PATTERN X)

5606 LIKELIHOOD DECISION SECTION

5612 LIKELIHOOD DECISION SECTION

5604 INTERLEAVER (PATTERN X)

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

5602 SOFT DECISION DECODING SECTION

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

5601 DEINTERLEAVER (FOR PATTERN X)

501 SEPARATION SECTION

FIG.59

(A)

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

(B)

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

Sa1, Sa3 AND Sb1, Sb3 DECODING

FIG.60

(A)

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

(B)

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

Sa1, Sa3 AND Sb1, Sb3 DECODING

FIG.61

(A)

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

DATA 1

DATA 11

DATA 185

DATA 195

DATA 6

DATA 16

DATA 190

DATA 200

(B)

BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 9

DATA 17

DATA 25

DATA 176

DATA 184

DATA 192

DATA 200

DATA 1

DATA 17

DATA 176

DATA 192

DATA 9

DATA 25

DATA 184

DATA 200

FIG.62

6000 SIGNAL PROCESSING SECTION

2405A INTERLEAVER

2405B INTERLEAVER

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

2403A DEINTERLEAVER

2404A DEINTERLEAVER

2403B DEINTERLEAVER

2404B DEINTERLEAVER

2402A INTERLEAVER

2402B INTERLEAVER

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

6002 HARD DECISION DECODING SECTION

6003 HARD DECISION DECODING SECTION

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

2401A DEINTERLEAVER

2401B DEINTERLEAVER

6001 MAXIMUM LIKELIHOOD DETECTION SECTION

FIG.63

6100 MULTI-ANTENNA TRANSMISSION APPARATUS

4701 SIGNAL SEPARATION SECTION

4704 CODING SECTION FOR (Sa0,Sa2)

4706 CODING SECTION FOR (Sa1,Sa3)

4708 INTERLEAVER (PATTERN X)

6101 INTERLEAVER (PATTERN X)

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

4712 SIGNAL SEPARATION SECTION

4715 CODING SECTION FOR (Sb0,Sb2)

4717 CODING SECTION FOR (Sb1,Sb3)

4719 INTERLEAVER (PATTERN Y)

6102 INTERLEAVER (PATTERN Y)

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.64

6200 MULTI-ANTENNA TRANSMISSION APPARATUS

TRANSMISSION DATA (m1, m2,⋯,mk)

6201A LDPC CODER (GENERATION MATRIX Ga INSPECTION MATRIX Ha)

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

TRANSMISSION DATA (n1, n2,⋯,nk)

6201B LDPC CODER (GENERATION MATRIX Gb INSPECTION MATRIX Hb)

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.65

6300 SIGNAL PROCESSING SECTION

6303 PROBABILITY DOMAIN Sum-product DECODING SECTION

6304 PROBABILITY DOMAIN Sum-product DECODING SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

6301 PROBABILITY DOMAIN Sum-product DECODING SECTION

6302 PROBABILITY DOMAIN Sum-product DECODING SECTION

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

502 NUMBER OF SIGNAL POINTS: 4

505 NUMBER OF SIGNAL POINTS: 4

501 SEPARATION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.66

6201A LDPC CODER

6601 INTERLEAVER

6201B LDPC CODER

FIG.67

MODULATED SIGNAL A

6801A CHANNEL ESTIMATION SYMBOL

6802A DATA SYMBOL

1 FRAME

MODULATED SIGNAL B

6804 CONTROL INFORMATION SYMBOL

6801B CHANNEL ESTIMATION SYMBOL

6802B DATA SYMBOL

TIME

FIG.68

6902A ERROR DECISION SECTION

6902B ERROR DECISION SECTION

6904 RETRANSMISSION REQUESTING SECTION

6907 DATA GENERATION SECTION

6909 TRANSMISSION SECTION

FIG.69

7001 CHANNEL ESTIMATION SYMBOL

7002 DATA SYMBOL

7003 RETRANSMISSION REQUEST INFORMATION SYMBOL

TIME

FIG.70

7000 MULTI-ANTENNA TRANSMISSION APPARATUS

7107A DATA STORAGE SECTION

7109A DATA SELECTION SECTION

201A CODING SECTION

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

7107B DATA STORAGE SECTION

7109B DATA SELECTION SECTION

201B CODING SECTION

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

7103 RECEPTION SECTION

7105 RETRANSMISSION REQUEST DETECTION SECTION

FIG.71

BASE STATION

TERMINAL

MODULATED SIGNAL A

MODULATED SIGNAL B

<1>

DATA 1A

DATA 1B

<2>

NO RETRANSMISSION REQUEST

<3>

DATA 2A

DATA 2B

<4>

RETRANSMISSION REQUEST

<5>

DATA 2A

<6>

NO RETRANSMISSION REQUEST

<7>

DATA 3A

DATA 3B

<8>

RETRANSMISSION REQUEST

<9>

DATA 3B

<10>

RETRANSMISSION REQUEST

<11>

DATA 3A

TIME

FIG.72

7200 MULTI-ANTENNA RECEPTION APPARATUS

7305 SIGNAL PROCESSING SECTION

404 SIGNAL PROCESSING SECTION

7303 CHANNEL INFORMATION/RECEIVED SIGNAL STORAGE SECTION

7304 RETRANSMISSION INFORMATION DETECTION SECTION

403-1A CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL A

403-1B CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL B

403-2A CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL A

403-2B CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL B

7301 CONTROL INFORMATION DETECTION SECTION

402-1 DESPREADING SECTION

402-2 DESPREADING SECTION

401-1 RADIO SECTION

401-2 RADIO SECTION

FIG.73

7305 SIGNAL PROCESSING SECTION

7401 DATA SELECTION SECTION

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

508 SIGNAL POINT REDUCTION SECTION

510 SIGNAL POINT REDUCTION SECTION

514 SIGNAL POINT REDUCTION SECTION

516 SIGNAL POINT REDUCTION SECTION

R1-2 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.74

DATA STORED BY RECEPTION APPARATUS

TIME

FIG.75

BASE STATION

TERMINAL

MODULATED SIGNAL A

MODULATED SIGNAL B

<1>

DATA 1A

DATA 1B

<2>

NO RETRANSMISSION REQUEST

<3>

DATA 2A

DATA 2B

<4>

RETRANSMISSION REQUEST

<5>

DATA 2A

DATA 2B

<6>

RETRANSMISSION REQUEST

<7>

DATA 2A

<8>

NO RETRANSMISSION REQUEST

<9>

DATA 3A

DATA 3B

TIME

FIG.76

BASE STATION

TERMINAL

MODULATED SIGNAL A

MODULATED SIGNAL B

<1>

DATA 1A

DATA 2A

DATA 3A

DATA 4A

DATA 1B

DATA 2B

DATA 3B

DATA 4B

<2>

RETRANSMISSION REQUEST

<3>

DATA 2A

DATA 4A

<4>

RETRANSMISSION REQUEST

<5>

DATA 2B

<6>

NO RETRANSMISSION REQUEST

<7>

DATA 5A

DATA 6A

DATA 7A

DATA 8A

DATA 5B

DATA 6B

DATA 7B

DATA 8B

TIME

FIG.77

TRANSMISSION SIGNAL A

TRANSMISSION SIGNAL B

TIME

FIG.78

7700 MULTI-ANTENNA TRANSMISSION APPARATUS

7107A DATA STORAGE SECTION

7109A DATA SELECTION SECTION

201A CODING SECTION

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

7107B DATA STORAGE SECTION

7109B DATA SELECTION SECTION

201B CODING SECTION

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

7103 RECEPTION SECTION

7105 RETRANSMISSION REQUEST DETECTION SECTION

FIG.79

X: RECEIVED SIGNAL POINT

●: CANDIDATE SIGNAL POINT WHICH BECOMES $a_0=0$

△: CANDIDATE SIGNAL POINT WHICH BECOMES $a_0=1$

FIG.80

MODULATED SIGNAL A

8901 CONTROL INFORMATION SYMBOL

8902 CHANNEL ESTIMATION SYMBOL

8903 DATA SYMBOL

70 SYMBOLS

MODULATED SIGNAL B

8902 CHANNEL ESTIMATION SYMBOL

8903 DATA SYMBOL

TIME

MODULATED SIGNAL A

8901 CONTROL INFORMATION SYMBOL

8902 CHANNEL ESTIMATION SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

22 SYMBOLS

2 SYMBOLS

22 SYMBOLS

2 SYMBOLS

22 SYMBOLS

MODULATED SIGNAL B

8902 CHANNEL ESTIMATION SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

TIME

MODULATED SIGNAL A

8901 CONTROL INFORMATION SYMBOL

8902 CHANNEL ESTIMATION SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

16 SYMBOLS

2 SYMBOLS

16 SYMBOLS

2 SYMBOLS

16 SYMBOLS

MODULATED SIGNAL B

8902 CHANNEL ESTIMATION SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

TIME

FIG.81

BASE STATION

TERMINAL

MODULATED SIGNAL A

MODULATED SIGNAL B

<1>

DATA 1A

DATA 1B

<2>

NO RETRANSMISSION REQUEST

<3>

DATA 2A

DATA 2B

<4>

RETRANSMISSION REQUEST

<5>

DATA 2A

DATA 2B

<6>

NO RETRANSMISSION REQUEST

<7>

DATA 3A

DATA 3B

<8>

RETRANSMISSION REQUEST

<9>

DATA 3A

DATA 3B

<10>

RETRANSMISSION REQUEST

<11>

DATA 3A

DATA 3B

TIME

FIG.82

404 SIGNAL PROCESSING SECTION

403-1A CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL A

403-1B CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL B

403-2A CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL A

403-2B CHANNEL FLUCTUATION ESTIMATION SECTION OF MODULATED SIGNAL B

7301 CONTROL INFORMATION DETECTION SECTION

402-1 DESPREADING SECTION

402-2 DESPREADING SECTION

401-1 RADIO SECTION

401-2 RADIO SECTION

FIG.83

7900 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

2301A INTERLEAVER

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.84

8000 SIGNAL PROCESSING SECTION

2405A INTERLEAVER

512 SOFT DECISION SECTION

2403A DEINTERLEAVER

2402A INTERLEAVER

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

2401A DEINTERLEAVER

501 SEPARATION SECTION

FIG.85-1

(A)

DATA SEQUENCE

DATA TRANSMITTED BY CHANNEL A

DATA TRANSMITTED BY CHANNEL B

(B)

DATA SEQUENCE

(C)

CHANNEL A

TIME

CHANNEL B

TIME

(D)

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

(E)

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

TIME

REPLICA OF DATA TRANSMITTED BY CHANNEL A

REPLICA OF DATA TRANSMITTED BY CHANNEL B

FIG.85-2

(F)

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

(G)

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

(H)

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

FIG.86

8200 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

2301A INTERLEAVER

202A MODULATION SECTION

204A RADIO SECTION

202B MODULATION SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.87

TRANSMITTED BY AN1

TRANSMITTED BY AN2

TRANSMITTED BY AN1

TRANSMITTED BY AN2

TRANSMITTED BY AN1

TRANSMITTED BY AN2

CHANNEL A

CHANNEL B

CHANNEL A

CHANNEL B

CHANNEL A

CHANNEL B

DATA SEQUENCE

FIG.88

TRANSMITTED BY AN1

TRANSMITTED BY AN2

TRANSMITTED BY AN1

TRANSMITTED BY AN2

TRANSMITTED BY AN1

TRANSMITTED BY AN2

DATA SEQUENCE

FIG.89

DATA #1 ···

DATA SEQUENCE

RENAMING

(B)

DATA #A1 ···

DATA SEQUENCE

FIG.90

(A)

CHANNEL A

DATA #A1 ···

CHANNEL B

DATA #B8 ···

FREQUENCY

CARRIER 1 ···

(B)

CHANNEL A

DATA #A6 ···

CHANNEL B

DATA #B8 ···

FREQUENCY

CARRIER 1 ···

(C)

CHANNEL A

DATA #A ···

CHANNEL B

DATA #B6 ···

FREQUENCY

CARRIER 1 ···

(D)

CHANNEL A

DATA #A6 ···

CHANNEL B

DATA #B10 ···

FREQUENCY

CARRIER 1 ···

FIG.91

8400 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

8401A INTERLEAVER

202A MODULATION SECTION

204A RADIO SECTION

8401B INTERLEAVER

202B MODULATION SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.92

8300 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

2301A INTERLEAVER

202A MODULATION SECTION

8301A SIGNAL-TO-SUBCARRIER ASSIGNMENT SECTION

204A RADIO SECTION

202B MODULATION SECTION

8301B SIGNAL-TO-SUBCARRIER ASSIGNMENT SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.93

(A)

TRANSMISSION DATA ON CHANNEL A

TRANSMISSION DATA ON CHANNEL B

(B)

CODED SYMBOL BLOCK

DATA SEQUENCE

(C)

CODED SYMBOL BLOCK

DATA SEQUENCE

(D)

DATA SEQUENCE

(E)

DATA SEQUENCE

(F)

CARRIER 1 ···

(G)

CARRIER 1 ···

FIG.94

DEINTERLEAVING

TRANSMISSION DATA ON CHANNEL A

TRANSMISSION DATA ON CHANNEL B

ERROR CORRECTION

FIG.95

9000 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

2301A INTERLEAVER

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

2301B INTERLEAVER

202B MODULATION SECTION

203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.96

(A)

DATA #1 ···

DATA SEQUENCE

AFTER INTERLEAVING

(B)

CHANNEL A

DATA #5 ···

CHANNEL B

DATA #12 ···

TIME

FIG.97

9200 SIGNAL PROCESSING SECTION

2405A INTERLEAVER

2405B INTERLEAVER

512 SOFT DECISION SECTION

2403A DEINTERLEAVER

2404A DEINTERLEAVER

2403B DEINTERLEAVER

2404B DEINTERLEAVER

2402A INTERLEAVER

2402B INTERLEAVER

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

2401A DEINTERLEAVER

2401B DEINTERLEAVER

501 SEPARATION SECTION

FIG.98

(A)

CHANNEL A

DATA #A1 ···

CHANNEL B

DATA #B1 ···

DATA SEQUENCE

INTERLEAVING

(B)

CHANNEL A

DATA #A1 ···

CHANNEL B

DATA #B1 ···

DATA SEQUENCE

PUNCTURING

(C)

CHANNEL A

DATA #A1 ···

CHANNEL B

DATA #B1 ···

DATA SEQUENCE

FIG.99

HORIZONTAL

VERTICAL

DATA #A1 ···

DATA #A8 ···

DATA #A50 ···

FIG.100

PRESENCE/ABSENCE OF DATA (1: PRESENT 0: ABSENT)

ADDRESS FOR HORIZONTAL DIRECTION

ADDRESS FOR VERTICAL DIRECTION

DATA

DATA #A1

···

FIG.101

TRANSMISSION DATA SEQUENCE

8601 MODULATION SECTION

8603 VECTOR MULTIPLEXING SECTION

CHANNEL STATE INFORMATION

8602 CHANNEL ANALYSIS SECTION

8604 TRANSMISSION ARRAY ANTENNA

TRANSMISSION MULTIBEAMS

PROPAGATION CHANNEL

RECEPTION MULTIBEAMS

8612 RECEPTION ARRAY ANTENNA

8613 MULTIPLEXED SIGNAL SEPARATION SECTION

8611 CHANNEL ANALYSIS SECTION

CHANNEL STATE INFORMATION

8614 SIGNAL PROCESSING SECTION

RECEIVED DATA SEQUENCE

FIG.102

TRANSMISSION SIGNAL A

TRANSMISSION SIGNAL B

3 MODULATED SIGNAL GENERATION SECTION

6 RADIO SECTION

13 RADIO SECTION

17 RADIO SECTION

19 DEMODULATION SECTION

FIG.103

TRANSMISSION APPARATUS

RECEPTION APPARATUS

FIG.104

TRANSMISSION SIGNAL A

TRANSMISSION SIGNAL B

TIME